# Tailored Expert Finding Systems for Vietnamese SMEs: A Five-step Framework

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***Abstract*—This study addresses the underexplored area of EFSs (EFS) tailored for business applications, with a specific focus on supporting Small and Medium Enterprises (SMEs). The principal objective of this research is to develop an EFS designed to cater to the needs of Vietnamese SMEs. The study methodology involves conducting in-depth interviews with Vietnamese SMEs to ascertain their requirements for Vietnamese EFSs. Subsequently, the research proposes an architectural model for the EFS and proceeds to develop the corresponding system. The EFS operates by collecting and analyzing data from diverse online sources to identify Vietnamese experts and individuals of Vietnamese origin who can provide valuable insights and support to enterprises operating in Vietnam. This research framework is guided by five key Husain (2019)'s issues: 1) Expertise evidence selection, 2) Expert representation, 3) Model building, 4) Model evaluation, and 5) Interaction design. By addressing these issues, the study aims to contribute to the development of an effective EFS tailored to the specific needs of Vietnamese SMEs in their quest to find and engage experts for business growth and innovation.**

***Keywords*—Expert Finding System (EFS); Small and Medium-sized Enterprises (SMEs); experts; Vietnamese expert resources; business expertise identification***

## I. INTRODUCTION

SMEs play a key role in Vietnam and Asia's economic development, constituting up to 98% of businesses in Asia and providing about 66% of private-sector jobs from 2007 to 2012 [1]. Howerver, SMEs have to deal with a multitude of challenges, especially the issue of recruiting high-quality labor resources [2]. They employ various personnel sourcing methods, including costly headhunter services and specialized training companies [3]. Alternatively, businesses can utilize recruitment websites and job exchange platforms, but these predominantly cater to common job positions, offering limited information about experts [4, 5]. Another option is independent online searches via platforms like Google and Bing, which yield articles and related information rather than lists of suitable candidates. Specialized social networking sites like LinkedIn and academic networks such as ResearchGate and Academia provide detailed expert profiles. However, expert data is often private and not easily accessible, hindering effective comparisons and selections [4]. Lastly, personal referrals are highly dependent on social networks, varying in effectiveness. To address these issues, one solution is leveraging technology for human resources and production efficiency [6, 7]. Technology enables SMEs to access crucial information quickly for decision-making and strategic management. In Vietnam, the labor force mainly consists of unskilled, low-skilled, and medium-skilled workers, with only 10 million qualified workers, representing 21% of the total labor force [8]. Consequently, this shortage results in intense competition among SMEs to attract and retain qualified experts who can drive innovation and growth [9].

An Expert Finding System (EFS) for business in recruitment is a highly effective solution that leverages advanced technology and data analytics to identify and connect with top talent in a more efficient and targeted manner Husain, et al. [10]. By analyzing candidates' skills, experiences, and qualifications alongside the specific needs and requirements of the job, this system streamlines the recruitment process, reducing time and cost while ensuring that the best-fit candidates are brought to the forefront. This study is a significant attempt to address an often-overlooked aspect of EFS in the domain of business applications, with a specialized focus on supporting SMEs operating in Vietnam. The primary aim of this research is to develop an EFS system matched precisely to the needs of Vietnamese SMEs. This study employed an in-depth interview methodology to gain insights into Vietnamese SMEs' requirements for expert human resources. Subsequently, the study advances with the proposal of an architectural model for the EFS, followed by the actual development of the system. This EFS functions by collating and analyzing data from diverse online sources to pinpoint Vietnamese experts and individuals of Vietnamese origin who possess the expertise necessary to aid enterprises in Vietnam. Guided by the five pivotal issues identified by Husain, et al. [10], including expertise evidence selection, expert representation, model building, model evaluation, and interaction design, this research hopes to contribute significantly to the evolution of an effective EFS, custom-tailored to meet the unique demands of Vietnamese SMEs.

In particular, this research will examine two main research questions:

- Question 1: How do Vietnamese Small and Medium Enterprises (SMEs) perceive their need for expert human resources, and what are the key challenges they face in identifying and engaging experts to support their business growth and innovation and their requirements for Vietnamese EFSs?
- Question 2: How can an Expert Finding System (EFS) be optimized for Vietnamese SMEs by effectively addressing the five key issues outlined by Husain, et al. [10], enabling efficient identification and engagement

of Vietnamese experts and individuals of Vietnamese origin to support SMEs in Vietnam?

The remainder of this study is organized as follows. Section II explores work concerning the Expert Finding System. The Methodology in Section III describes the research design, survey participant information, and system design. The Results in Section IV presents the outcomes of the in-depth interview and the proposed framework of the Expert Finding System for Vietnamese SMEs. Finally, the last section i.e. Section V provides a summary of the results, discusses them, and indicates future work.

## II. Expert Finding Systems

The development and deployment of EFS, have enabled users to discover and search for experts and high-quality human resources in various fields for collaboration or knowledge acquisition [11]. Singh in [12] conducted a study highlighting the essential need for organizations to swiftly identify experts in different domains. However, this task presents challenges due to limited and unevenly distributed information about experts. Furthermore, the requirements of those seeking experts are often unclear, and past expert performance lacks sufficient visibility, making it difficult to assess and quantify expertise. The dynamic nature of experts, who may switch jobs and research areas, further complicates expert identification. Additionally, many complex problems require the collective intelligence of diverse experts, underscoring the necessity of developing an expert finding information system to expedite problem-solving and enhance organizational efficiency [12].

Various studies have explored EFSs to address enterprise challenges and global issues [11, 13]. The development of these systems involves the discovery of experts in specialized fields, an examination of existing systems in these domains, and the proposal of models to guide future system design and development decisions [13]. Organizations can also leverage commercial services and solutions to identify experts and evaluate EFSs, taking into account their unique characteristics and the most effective implementation methods [11]. Moreover, In SMEs' pursuit of expert human resources, recent research indicates that social globalization positively influences gender equality in employment opportunities [14].

In Singh [12] study, the essential attributes of an ideal EFS are outlined. This comprehensive framework envisions a system that operates efficiently and effectively. Furthermore, it underscores the significance of categorizing expertise through a subject classification scheme, ensuring that users can easily access and navigate the wealth of knowledge available. Moreover, it strongly emphasizes the quantification of expertise, enabling the system to rank experts, thus aiding users in identifying the most suitable individuals for their specific needs. Ensuring the reliability of information sources is another aspect, ensuring the integrity and accuracy of the system's output. Moreover, the framework envisions fostering expert communities, facilitating collaboration and knowledge sharing among professionals. Lastly, the system is geared towards identifying locally available experts, enhancing accessibility and relevance for users seeking expertise within their geographic vicinity.

Furthermore, apart from research on EFSs for organizations, some studies delve into technical aspects related to collecting and processing expert information and algorithms for accurate expert identification, evaluation, and ranking. Taie, et al. [15] presents methods for classifying expertise, including domain-based classification (enterprise/organization and online community) and technique-based classification (machine learning and graph techniques). However, it is worth noting that combining content-based expertise indicators with social relationships does not completely resolve the issues related to expert identification and ranking [15]. Additionally, Singh [12] and Wang, et al. [16] highlight prominent expert finding methods, such as unstructured data mining, social networking sites, contact management systems, and self-disclosure data from experts.

According to Husain, et al. [10], EFSs have found application across various domains, including academics, enterprises, medicine, online knowledge-sharing communities, online forums, and social networks. In this study, Husain, et al. [10] asserts that defining specific tasks for expert finding systems in certain domains can be challenging. Consequently, there is a research gap in understanding the tasks that expert search systems support for businesses, especially small and medium-sized enterprises (SMEs). This gap will be the focus of the current study.

Moreover, while numerous studies have addressed technical aspects of EFSs, only a limited number of research into the specific needs of Vietnamese SMEs in locating experts in their respective fields to fulfill their human resource requirements effectively have been identified.

Lin, et al. [17] and Husain, et al. [10] have critically examined existing research in the field, highlighting several noteworthy gaps that demand attention and resolution. First and foremost, they emphasize that most studies in the field of EFSs have only focused on the academic domain, and very little is known about EFSs in other domains where expert knowledge is critical. Also, these studies bring up data-related problems that have not been properly dealt with yet, like security issues, data inconsistencies (like having multiple names for the same person or names that sound similar for different people), and the issues surrounding the completeness of expert information. Addressing these issues calls for the development of complex algorithms capable of seamlessly integrating data from diverse sources and tailoring expert-finding models to specific tasks and domains, a task that remains largely unmet. Moreover, Lin, et al. [17] and Husain, et al. [10] stress the imperative of fostering diversity in system development by creating combined datasets from multiple sources, promoting more versatile and robust solutions. Lastly, the identification of expert groups to solve interdisciplinary problems is highlighted as an essential requirement across various applications, underscoring the significance of collaborative and multidisciplinary approaches in expertise seeking. These identified gaps serve as critical pointers for future research, shedding light on the areas in need of further exploration and innovation within the realm of expert finding.

The expert finding task involves five key procedural aspects [10]:

- Expertise evidence selection: This step focuses on extracting data and information relevant to a person's expertise, which is crucial for determining their status as an expert in a particular field.
- Expert representation: EFS aim to provide users with information that aids in not only locating experts but also in selecting the most relevant ones. This requires identifying valuable information for decision-making, considering both documented evidence and contextual factors.
- Model building: Model building encompasses pre-processing, indexing, and modeling. Pre-processing involves handling diverse data sources, recognizing candidate expert identifiers (e.g., names, emails), and addressing challenges like named entity recognition and disambiguation. Modeling and retrieval involve creating models that associate candidate experts with user queries and rank them based on these associations, utilizing various methods such as probabilistic, network-based, and voting models.
- Model evaluation: Evaluating the efficiency of EFS is typically done using test collections (datasets) to assess their performance in retrieving relevant experts in response to user queries.
- Interaction design: Presenting expert search results to users is a critical practical concern. It involves displaying not only ranked lists of experts but also related documents, conferences, journals, and contact details to aid users in assessing the relevance of experts. Additional information like photos, affiliations, publications, and projects can help users gauge an expert's seniority and expertise alignment.

From an in-depth review of relevant EFS literature, we are dedicated to developing a tailored EFS for Vietnamese SMEs. This study will address the five key issues identified by Husain, et al. [10] and overcome the limitations mentioned by Lin, et al. [17]. The proposed EFS will incorporate all essential features from Singh [12] study, including robust data processing, advanced modeling, efficient retrieval, and a user-friendly interface. Our objective is to not only meet the specific requirements of Vietnamese SMEs but also set a global standard in EFS, adhering to best practices in the academic literature. Through this effort, we aim to enhance the expertise-seeking process for Vietnamese businesses, contributing to their growth and success in a dynamic marketplace.

## III. METHODOLOGY

### A. Research Design

The research process is structured into two distinct stages, each aligned with a research question.

For the first question, firstly, we conducted a review of EFSs to gain an understanding of the research problem and identify gaps in previous studies. Next, primary data was collected from businesses to gain a deeper understanding of the challenges they face when finding and using experts to support their activities. The following steps were taken:

- Determine research goals and questions
- Plan data collection
- Select some survey business
- Conduct interviews
- Analyze the interview results, focusing on identifying the problems that businesses are facing in the process of finding and using experts to support business activities.

For the second question, reliance is placed on the five key issues mentioned by Husain, et al. [10] with proposed methods for handling these issues:

- Identify details for each issue: Gather specific information about each of the 5 key issues highlighted by Husain, et al. [10].
- Collect relevant data: Gather data that is relevant to these issues.
- Develop a system: Create a system or framework to address each of the five key issues.
- Check solution evaluation: Evaluate the effectiveness of the proposed solutions for each of the five key issues. This can be done through data analysis, expert feedback, or user testing.

By following these steps, we can effectively provide practical solutions to the challenges faced in the process of finding experts.

### B. Participants

The authors conducted in-depth interviews with 20 representatives of SMEs operating in various fields, including logistics, construction and architecture, information technology, and services (see Table I). Most of these enterprises are concentrated in Hanoi, with a few also located in Ho Chi Minh City or having branches in different areas. The number of permanent employees in each enterprise ranges from 10 to more than 200. The interviews focused on surveying the needs for general human resources and expert human resources in today's businesses. Additionally, the authors surveyed the need for information systems to support searching and linking with customers' human resources in different positions and locations. The interviews were mainly conducted using audio or video calls between December 2021 and January 2022. Most of the interview participants held important positions in the enterprises, such as General Director/Director, Head of department, or Executive Director. The data obtained from the interviews will be coded and synthesized according to groups of indicators, thereby synthesizing into a number of criteria to evaluate the current state of human resource needs in SMEs today. The survey data from the interviews related to how businesses seek sources of experts was used by the research team to propose solutions for building a system that meets the human resource needs of businesses. The system will provide expert information sources for businesses and create an information channel connecting businesses and experts in each field.

TABLE I. INTERVIEW CANDIDATES

| # | Industry | Number of employees | Number of enterprises | Participants |
|---|---|---|---|---|
| 1 | Logistics | 50-200 | 2 | Delivery Director, Branch Head Manager |
| 2 | Information Technology | 22-210 | 4 | Director |
| 3 | Construction | 30-600 | 7 | Director, Deputy Director, Head of Department |
| 4 | Service | 10-150 | 3 | Director |
| 5 | Manufacture | 23-120 | 2 | Director |
| 6 | Architecture | 10-30 | 2 | Director |

### C. System Design

The system is built on a robust foundation that encompasses data collection from diverse sources, data integration, entity resolution, and indexing to ensure the accuracy and accessibility of expert information. The use of NoSQL databases for storing expert data is a practical choice, offering flexibility, scalability, and rapid performance, all essential for accommodating the growing volume of expert data over time. The model building process is systematic, involving input, pre-processing, entity creation, modeling and retrieval, and output generation (see Fig. 1), all aimed at providing users with a seamless experience in finding and connecting with experts. The emphasis on expert ranking is notable, as it helps users efficiently identify experts with substantial expertise and influence in their respective domains. The integration of a learning-to-rank algorithm for expert ranking is a forward-looking approach that promises to improve the quality of expert suggestions.

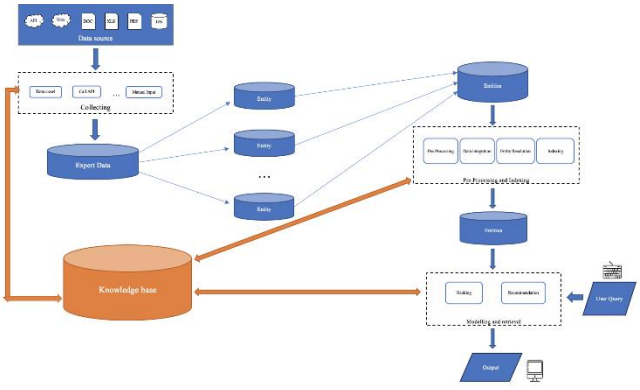


Fig. 1. System architecture model.

## IV. RESULTS AND DISCUSSION

### A. Understanding the Expert Resource Needs of Vietnamese SMEs

The interview results revealed several issues related to the needs and challenges businesses face when looking for experts, as follows:

*1)* Concerning the enterprise's available human resources: Assessing the organization's current human resources is the first step in determining the need for additional human resources. Does this human resource meet the business's work requirements during its operations?

According to the results of the interviews, the majority of businesses continue to lack significant human resources in numerous departments. Many positions, including senior managers, middle managers, department heads, team leaders, and employees, require additional personnel. In it, a respondent remarked:

"Positions that we often lack and need to recruit are middle managers and team leaders. However, finding the ideal candidate is not simple."

Most interview participants said that adding human resources is often done depending on the expansion needs of the business.

Typically, the missing human resources consist of both skilled and unskilled labor. All businesses reported a shortage of qualified personnel. One director of business explained:

"It is easier to supplement unskilled labor than highly skilled one. Finding and securing an agreement to collaborate with experts is time-consuming and difficult."

This result was also mentioned in the research of Thang and Nguyen [18], which noted the significant shortage of skilled and qualified human resources within Vietnamese businesses.

Therefore, it is clear that most businesses lack an adequate permanent workforce and must, therefore, consider expanding their human resources, particularly by adding expert personnel, to support their activities.

*2)* Regarding the importance of finding expert personnel: The majority of interviewees indicated that their organizations need external expert resources. However, companies have shown that the need to search depends on their operational requirements. These needs frequently arise when:

"The enterprise has a new project and requires experts to advise and support phases of the project or fulfill the requirements of fixed, recurring jobs."

Moreover, if a company wishes to expand its operations to a new international market, it will find Vietnamese experts residing in that country. A respondent listed the following as activities for which businesses seek assistance from specialists:

"Marketing, transportation, production, sales, and financial management" as well as "information and communication technology, legal, and risk management" are a few activities that need additional external human resources.

Besides, the European Commission [19] also points out that "*a virtual organization consists of a small core of fulltime employees and outside specialists temporarily hired as needed to work on projects.*" So, acquiring human resources with specialized knowledge from external sources, including foreign experts, is necessary.

*3)* Regarding the need for consulting and cooperation with experts: All interviewees indicated that they are willing to reach out to experts in the business's area of interest if they require expert advice or consulting services. These individuals also indicated that they had reached out to experts to request collaboration. This demonstrates that businesses desire assistance from individuals who have an in-depth understanding of the problems they are facing and need to solve.

In addition, quite a few instances have occurred when asking in greater detail about the outcomes of contacts with experts. Only a small portion of these got to collaborate. The majority of the remaining suggestions have been rejected to varying degrees.

"When I contact outside experts, they politely decline for a variety of personal reasons. Typically, this is due to an abundance of current work."

This is a significant obstacle for businesses when they want to collaborate with experts.

Thus, beyond the difficulties businesses encounter in finding and reaching out to experts, are there also impediments associated with collaborating with them? Several primary causes are listed, including:

"Not understanding the challenges faced by businesses"

"Unclear understanding of the business operating procedure."

"Unable to agree on conditions for cooperation"

Thus, it can be seen that another challenge businesses face when they want to collaborate with external human resources is how to help them understand the business's operating processes so they can provide the most effective and efficient support.

When interviewees were asked to choose between training existing workers themselves to meet the needs of the business and inviting experts to collaborate in each stage or project, more than half of the responses selected *"Use their employees"* rather than *"Invite experts to cooperate according to needs"* due to the many difficulties mentioned. An analysis of these processes reveals that, in addition to a fixed salary and other benefits, the implementation of the training workers will take a significant amount of time. Otherwise, if enterprises choose to work with experts who are available, they will only have to compensate based on the volume and effectiveness of their work.

Despite understanding the importance of locating and collaborating with experts, it is evident from the results of the interviews that there are numerous difficulties in the search process or contact with them.

*4)* Regarding the methods and tools used to find experts: According to interviewees, some methods and tools that businesses frequently use to find or contact experts are also critical issues (see Table II). So, they must be carefully considered and evaluated.

Surprisingly, all of the responding managers mentioned the method of finding personnel *"through relationships"* while the other methods were not used much. This leads to the conclusion that the current tools for supporting human resource search activities do not meet the needs of businesses adequately.

TABLE II. METHODS AND TOOLS THAT BUSINESSES FREQUENTLY USE TO FIND EXPERTS

| Number of Participant | Methods/tools | Comments |
|---|---|---|
| 5 | Search engines | "Not very efficient. Finding suitable human resources remains a difficult challenge."<br>"Low quality." |
| 8 | Job search websites | "At present, there are numerous human resources recruitment channels, but they frequently do not meet the appropriate needs or the quality is inconsistent, slow, or non-responsive."<br>"It is time-consuming." |
| 2 | Expert finding systems | "Finding human resources that meet expectations is quite difficult."<br>"The system is quite quick, but its effectiveness cannot be fully evaluated until a face-to-face interview is conducted. However, this is a preliminary initial step." |
| 20 | Interpersonal relationships | "This method is quite flexible, high efficiency but waste time and difficult to find number of experts at the same time ." |

*5)* Concerning for finding experts in the field of interest: In light of the current situation that SMEs are facing in the process of searching for experts from outside, the authors have proposed to build an EFS that stores databases in the form of "metadata" about expert profiles for businesses to meet the needs of external personnel search and cooperation. A system with a large quantity of data about human resources who have in-depth knowledge in a variety of business-relevant areas. This system will be developed at no cost to establish a channel of communication between businesses and experts in various fields, and it can also introduce businesses to suitable experts from others if the system does not contain any relevant information.

To implement this idea, the authors conducted interviews with participants regarding system-related issues. The majority of interviewees stated that a specialized expert finding system for SMEs is essential. And the ideal system must provide the following essential features (see Table III):

Businesses have concerned the finding expert, with all of them expressing readiness to evaluate and offer feedback on this system once it's finalized.

### D. Addressing Key Issues and Enhancing Efficiency of EFS for Vietnamese SMEs

Based on the insights gathered from the interviews, our objective is to develop an EFS that caters to the demands of locating proficient human resources for Vietnamese businesses. The system's database will be a substantial repository of big data integrated with the Knowledge Base System. The application of data processing techniques extends beyond facilitating information retrieval; it also delves into deeper data comprehension, uncovering interrelationships between data entities, and proffering actionable insights. This serves to motivate and support users in making informed decisions.

TABLE III. SEVERAL FEATURES REQUIRED IN EFS SYSTEMS DESIGNED FOR BUSINESS

| # | Features | Requirements |
|---|---|---|
| 1 | Find an expert | Find the expert who most closely aligns with the user's query |
| 2 | Booking an Expert | Users submit a request for a specific job. The system will respond a list of potential experts suitable for the job position. |
| 3 | Connect or collaborate with experts | Submit a request for an appointment or propose collaboration with a particular expert |
| 4 | Introduce/Suggest experts | An expert can suggest another expert they are acquainted with for a customer's requirements. |
| 5 | Expert Q&A | Customers ask questions, experts answer. |

Throughout the system development process, we gained valuable insights into the global landscape of Expertise Finding System implementations, with a particular emphasis on extensive research articles about EFS. Notably, a study conducted by Husain, et al. [10] has identified challenges within EFS systems that require resolution, including expertise evidence selection, expert representation, model development, model evaluation, and interaction design. These findings serve as a foundational framework for our endeavor to propose methods and techniques to address the aforementioned issues within our EFS system.

*1)* Expertise evidence selection: Expert information can be collected either manually or automatically, but it can only work against a pre-existing knowledge base (see Fig. 2). The knowlege base consists of a list of titles and positions, jobs by industry or field, high-ranking universities, and companies where many professionals work, certificates. The knowledge data comes from various sources drawn from predefined categories, such as the Yellow Pages directory, the research journals directory, the top-ranked universities directory, or the large-cap companies directory [20]. This dataset will be updated regularly during data analysis and processing.

Moreover, the Knowledge Base also facilitates the handling of Vietnamese data, including information pertaining to 3,000 career types in both Vietnamese and English languages, with synonym support. Additionally, it encompasses the names of nearly 200 countries, complete with geographical coordinates and names in Vietnamese as well as various other languages, along with phone numbers, to accommodate international customers utilizing global phone numbers. The Knowledge Base further includes 200 common Vietnamese names or surnames (unigrams) and almost 10,000 common Vietnamese surname combinations (bigrams) to aid in the identification of Vietnamese names. We have developed a Natural Language Processing (NLP) algorithm specifically designed for detecting Vietnamese names.

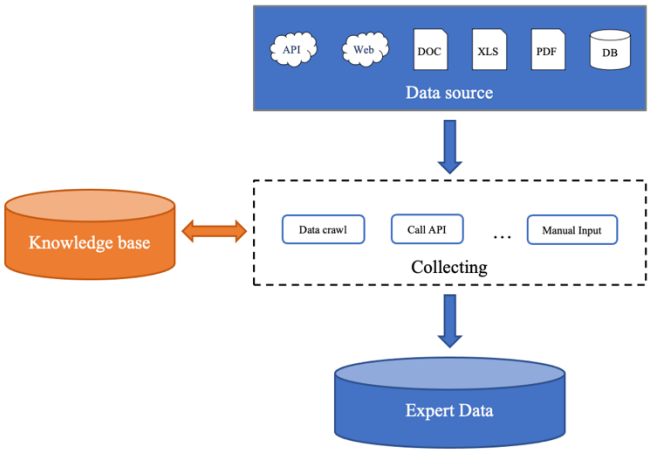


Fig. 2. Expertise selection.

The acquisition of data involves sourcing information from a diverse array of outlets, including the web, textual sources, social networks, APIs, and more. This process of gathering data is executed through a combination of manual and automated techniques. A proficient team will oversee the manual data collection aspect, while an automated data collection program will be deployed across multiple search servers. This automated system scans for pertinent information, extracts the requisite data, and deposits it into an unstructured database to facilitate subsequent analysis. In the context of data collection, the primary objective is to ascertain whether an individual possesses expertise in a specific field. To accomplish this, it is imperative to amass pertinent information pertaining to the individual.

Expert representation: Expert information needs to be effectively organized and stored, making it readily accessible and useful for various applications, such as expert ranking, collaboration, or expertise matching [21]. This information can be divided into the following collections:

*a)* Expert's Personal information

ID (Primary Key): An auto-incrementing unique identifier for each expert.

Name: The full name of the expert.

Title/Position: The expert's job title or position.

Contact Information:

Email: The expert's email address.

Phone: The expert's phone number.

Education: Details about the expert's educational background. This field can be more complex and structured, with subfields like:

Degree: The type of degree (e.g., Bachelor's, Master's, Ph.D.).

Institution: The name of the educational institution.

Year: The year of graduation.

Skills: A field to list the skills and areas of expertise possessed by the expert. This can be a text field or a list of keywords.

Areas of Expertise: A field to specify the main areas or subjects in which the expert has expertise. This can also be a text field or a list of keywords.

*Awards and Honors*: Any awards or honors received by the expert, with subfields like:

Award Name: The name of the award.

Year: The year the award was received.

Goal Vision: The expert's goal and vision.

Work Experience: Information about the expert's work history. This field can also be structured, with subfields like:

Position: The job title.

Company: The name of the company.

Start Date: The start date of the job.

End Date: The end date of the job.

Projects: Information about projects that were joined by expert.

*Publications*: A list of publications authored by the expert. This field can be structured with subfields like:

Title: The title of the publication.

Publication Date: The date the publication was released.

Books/Book Chapters: A list of books or book chapters authored by the expert.

Patents/Inventions: A list of patents or inventions authored by the expert.

*b)* Relationships

Collaboration, Association and Mentorship: The name of the organization, company or country the expert is affiliated with.

*c)* Presence

Social Media Profiles: Links or handles to the expert's social media profiles, if applicable.

Personal Website: Links to the expert's personal website.

*d)* Data Source

A list of data sources where expert information is collected.

Experts can be stored in a data schema that presents in the Fig. 3.

NoSQL databases stand out as an excellent choice for the storage of expert information, thanks to their versatility, scalability, and rapid performance [22]. NoSQL databases, including those employing key-value pairs and document-oriented structures, offer the flexibility to store expert information in a manner that is both adaptable and hierarchical. This facilitates effortless access and updates. Furthermore, these databases are engineered to handle substantial volumes of data and traffic without compromising on performance, rendering them well-suited for the enduring storage of expanding expert data over time. Notably, NoSQL databases excel in accommodating "one-to-many" relationships between entities, such as experts and their publications. As a result, all of an expert's details can be conveniently encapsulated within a single document, simplifying the retrieval and maintenance process.


Fig. 3. Data schema.

*2)* Model building: An expert finding system's model building process involves 2 steps [10] (see Fig. 4):

*a)* Pre-processing and Indexing: Cleaning, formatting, and transforming the raw expert data to make it consistent and suitable for analysis. This includes removing duplicates and irrelevant entries, standardizing data formats, handling missing data, tokenizing and normalizing text data, and creating indexes on specific fields or attributes to optimize query performance. Based on the Knowledge Base, the data will be classified, extracted into information fields, and concatenated to form experts.

*b)* Modelling and Retrieval: Developing a model that can analyze and rank the experts with support from the knowledge base. This model may use various techniques, such as machine learning, natural language processing, or weighted scoring, to evaluate and rank experts based on specific criteria. It takes user queries or criteria as input and searches the knowledge base for relevant experts. The retrieval system uses the model to score and rank experts based on how well they match the query, returning a list of suggested experts that meet the user's requirements.

This process enables users to efficiently discover and engage with experts in a given field or domain, and its effectiveness depends on the quality of data input, the accuracy of the model, and the efficiency of the retrieval mechanism.

Data cleaning and preprocessing are essential for ensuring accurate and reliable expert data. This involves standardizing

data formats, eliminating duplicates, handling outliers, and processing text data by removing special characters, tokenizing, eliminating stop words, and performing stemming/lemmatization. Encoding categorical data, scaling, and normalization are crucial. Finally, data splitting into training, validation, and test sets is necessary for building machine learning models. Data integration for expert information involves consolidating data from various sources to create a comprehensive dataset. This can be achieved through methods like data warehousing, ETL processes, data replication, data virtualization, and data federation. It ensures accessibility and accuracy in expert data for various applications. Entity resolution is vital for ensuring data accuracy in expert information. It involves identifying and consolidating records representing the same entity across diverse sources with variations in attributes. Preprocessing is essential to mitigate these variations. Indexing is used to improve search efficiency by adding indexes to relevant fields, allowing faster data access and reduced search times. It's especially useful in expert information systems for storing expert descriptions, background information, and relationships between experts. Multiple keywords and Boolean operators can be used to refine searches.

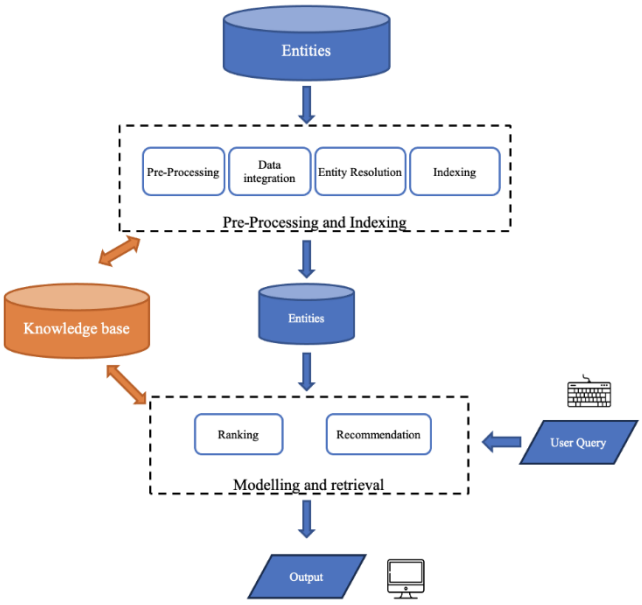


Fig. 4. An expert finding system's model building process.

Managing expert information involves understanding user queries, modeling them, retrieving relevant data, and providing accurate responses. This process begins with interpreting user intent through natural language understanding, query deconstruction, preprocessing, and semantic analysis. The technology also offers recommendation, reducing the need for users to enter complete queries by providing prompt suggestions related to service types, specialties, expert locations, company names, and individual names. The query is then modeled to create a structured representation, and information retrieval is performed, ranking and scoring results. We used Learning-to-rank algorithms to experiment with ranking experts, providing a list of suggested experts for various positions, saving time in the selection process.

*3)* Model evaluation: Various evaluation methods can be employed, depending on the specific function. For example:

*a)* Information retrieval: Precision, Recall, F1-Score, Mean Average Precision are used to evaluate the relevance and ranking of search results [23].

*b)* Recommendation: Precision at K (P@K), Mean Reciprocal Rank (MRR), or click-through rates are used to assess the quality of suggested queries [24].

*c)* Entity resolution: Measures like Precision, Recall, and F1-Score are used to evaluate the accuracy of entity resolution [25].

*d)* Ranking: Precision, recall, F1-Score, MAP, NDCG, or other relevant metrics are used to judge the quality of the ordered search results [26].

Moreover, domain experts with expertise in the system's relevant field offer subjective evaluations of its performance, assessing factors like the quality and relevance of search results, the precision of auto-suggestions, the efficiency of entity resolution, and the overall user experience.

*4)* Interaction design: Interaction design for the system, along with a booking feature, is a pivotal element in delivering a user-friendly and efficient experience. To start, the search functionality should be intuitive and easily accessible, empowering users to input their queries and apply filters to refine their results. The system should efficiently display a list of expert profiles after a search, offering a comprehensive summary of each expert's qualifications and availability (see Fig. 5). A clear and organized layout is essential to help users quickly identify the expert who best matches their needs.


Fig. 5. Advance expert search.

Upon selecting an expert profile, users should gain access to a detailed view of the expert's background, credentials, and reviews from previous clients. Additionally, the interaction design should incorporate easy-to-use booking features (see Fig. 6). Users should be able to select available time slots, input booking details, and confirm appointments with minimal effort. To prevent scheduling conflicts, real-time availability updates are crucial, ensuring a seamless and frustration-free booking process.

Our proposed system's information presentation on a world map offers users an extensive and user-friendly data visualization tool (see Fig. 7). Users have the flexibility to zoom in and out of the map to access statistical data across various geographic scales, from continents to individual towns. This feature not only empowers users to explore data in-depth but also provides a global perspective on the Vietnamese community's reach and activities. The automatic aggregation and real-time display of statistics on the map ensure that users have access to the most up-to-date and comprehensive information. This functionality enhances the system's usability and enables users to make informed decisions or gain a better understanding of the Vietnamese community's global presence.

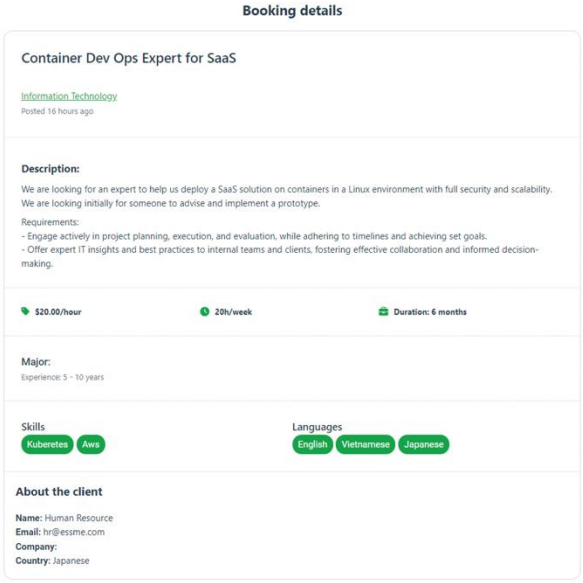


Fig. 6. Expert booking detail.

Fig. 7. Expert map.

## V. Conclusion and Future Work

In conclusion, the purpose of the current study was to explore the EFSs customized for business applications, with a particular emphasis on SMEs operating in the Vietnamese context. By conducting in-depth interviews with Vietnamese SMEs, the study provides requirements and challenges these enterprises face when seeking expert resources. Subsequently, the research proposed an architectural model for an EFS for Vietnamese SMEs. This EFS automatically collect data from a multi sources to identify Vietnamese experts. Morover, this study is founded on a well-established framework that addresses five critical issues derived from Husain's seminal work, providing a roadmap for the development of an efficient and tailored EFS. Through the exploration of these key issues, the insights gained from this study may be of assistance to the creation of a specialized EFS capable of meeting the distinct needs of Vietnamese SMEs as they embark on their quest to locate and collaborate with experts in pursuit of business growth and innovation.

Further experimental investigations are needed to develop and refine the proposed EFS system. This should encompass the comprehensive design, construction, and testing of the system to ensure its seamless integration into the operations of Vietnamese SMEs. Continuous data collection and analysis must remain at the core, allowing the system's knowledge base to evolve in real-time and provide the most up-to-date expert information. Enhancement of the EFS model using advanced technologies such as machine learning and natural language processing will significantly improve the accuracy and efficiency of expert recommendations, catering to the unique requirements of Vietnamese SMEs. User feedback and extensive testing will fine-tune the system, making it even more user-friendly and effective for SMEs. In addition, an emphasis should be placed on security measures, scalability, and the potential expansion of the system to serve a broader range of industries and regions. Moreover, it is crucial to conduct long-term assessments to assess the lasting impact of the EFS on Vietnamese SMEs, tracking factors like increased efficiency, cost savings, and tangible business growth.

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